

FORM PTO-1596 U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		ATTORNEY'S DOCKET NUMBER: BE 9568 Cas 32 U.S. APPLN. NO. (If known, see 37 CFR 1.5)
INTERNATIONAL APPLICATION NO.: PCT/FR00/01545	INTERNATIONAL FILING DATE: 6 JUNE 2000	PRIORITY DATE CLAIMED: 28 JUNE 1999
TITLE OF INVENTION: ANALYSING METHOD AND DEVICE WITH A VIEW TO THE AUTOMATIC SORTING OF PRODUCTS SUCH AS PIECES OF FRUIT		
APPLICANT(S) FOR DO/EO/US: Philippe BLANC		
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:		
1. <input checked="" type="checkbox"/>	This is a FIRST submission of items concerning a filing under 35 U.S.C. 371.	
2. <input checked="" type="checkbox"/>	This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371.	
3. <input checked="" type="checkbox"/>	This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).	
4. <input checked="" type="checkbox"/>	A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.	
5. <input checked="" type="checkbox"/>	A copy of the International Application as filed (35 U.S.C. 371(c)(2))	
a. <input checked="" type="checkbox"/>	is transmitted herewith (required only if not transmitted by the International Bureau).	
b. <input checked="" type="checkbox"/>	has been transmitted by the International Bureau. (see attached copy of PCT/IB/308)	
c. <input type="checkbox"/>	is not required, as the application was filed in the United States Receiving Office (RO/US).	
6. <input checked="" type="checkbox"/>	A translation of the International Application into English (35 U.S.C. 371(c)(2)).	
7. <input type="checkbox"/>	Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)).	
a. <input type="checkbox"/>	are transmitted herewith (required only if not transmitted by the International Bureau).	
b. <input type="checkbox"/>	have been transmitted by the International Bureau.	
c. <input type="checkbox"/>	have not been made; however, the time limit for making such amendments has NOT expired.	
d. <input type="checkbox"/>	have not been made and will not be made.	
8. <input type="checkbox"/>	A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).	
9. <input checked="" type="checkbox"/>	An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).	
10. <input type="checkbox"/>	A translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).	
Item 11. to 16. below concern document(s) or information included:		
11. <input checked="" type="checkbox"/>	An Information Disclosure Statement under 37 CFR 1.97 and 1.98.	
12. <input type="checkbox"/>	An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.	
13. <input checked="" type="checkbox"/>	A FIRST preliminary amendment.	
14. <input type="checkbox"/>	A SECOND or SUBSEQUENT preliminary amendment.	
15. <input type="checkbox"/>	A substitute specification.	
16. <input type="checkbox"/>	A change of power of attorney and/or address letter.	
17. <input checked="" type="checkbox"/>	Other items or information:	
INTERNATIONAL PRELIMINARY EXAMINATION REPORT (PCT/PEA/409), INTERNATIONAL PUBLICATION, INTERNATIONAL SEARCH REPORT (PCT/ISA/210), Forms PCT/IB/304 and PCT/IB/308, ABSTRACT on a separate sheet, APPLICATION DATA SHEET		

U.S. APPLICATION NO. (If known) 107019226

INTERNATIONAL APPLICATION NO.
PCT/FR00/01545

ATTORNEY'S DOCKET NO.
BE 9568 Cas 32

17. ☒ The following fees are submitted:

BASIC NATIONAL FEE (37 CFR 1.492(a)(1)-(5)):

Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO \$ 1,040.00

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO \$ 890.00

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$ 740.00

International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$ 710.00

International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) \$ 100.00

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Surcharge of \$130.00 for furnishing the oath or declaration later than months from the earliest claimed priority date (37 CFR 1.492(e)).

\$

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	\$
Total claims	15 - 20 =	0	X \$18.00	\$
Independent claims	2 - 3 =	0	X \$84.00	\$
MULTIPLE DEFENDENT CLAIMS(S) (if applicable)			+ \$280.00	\$
TOTAL OF ABOVE CALCULATIONS =			\$ 890.00	\$
Reduction of 1/2, if applicant is entitled to Small Entity status under 37 CFR 1.27.			+	\$
SUBTOTAL =			\$ 890.00	\$
Processing fee of \$130 for furnishing the English translation later than months from the earliest claimed priority date (37 CFR 1.492(f)).			+	\$
TOTAL NATIONAL FEE =			\$ 890.00	\$
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property			+	\$
TOTAL FEES ENCLOSED =			\$ 890.00	\$
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a. ☒ A check in the amount of \$ 890.00 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. 25-0120 in the amount of \$ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required by 37 CFR 1.16 and 1.17, or credit any overpayment to Deposit Account No. 25-0120. A duplicate copy of this sheet is enclosed.

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PATENT TRADEMARK OFFICE

December 28, 2001

By

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PATENTS

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

#3/A

In re application of

Philippe BLANC

Box PCT

Serial No. (unknown)
(PCT/FR00/01545)

Application Branch

Filed December 27, 2001

ANALYSING METHOD AND DEVICE
WITH A VIEW TO THE AUTOMATIC
SORTING OF PRODUCTS SUCH AS
PIECES OF FRUIT

PRELIMINARY AMENDMENT

Commissioner for Patents

Washington, D.C. 20231

Sir:

Prior to the first Official Action and calculation
of the filing fee, please amend the above-identified applica-
tion as follows:

IN THE CLAIMS:

Claims 4-8, 11, 13 and 14 have been amended as
follows:

--4. (amended) An analysing method as claimed in claim
1, wherein a speed of rotation of the rollers (3, 4) is
determined which is adapted so that a product of average
diameter undergoes a rotation on itself with an angle of
rotation substantially equal to 125.5° between the first and
second stations (5, 6), and with an angle of rotation
substantially equal to 109° between the second and the third
stations (6, 7).--

--5. (amended) An analysing method as claimed in claim
2, wherein the distance between the first and second stations

(5, 6) is substantially equal to 1.15 times the distance between the second and third stations (6, 7).--

--6. (amended) An analysing method as claimed in claim 2, wherein the cameras (8, 9) of the station (5) comprising two cameras are arranged in such a way that their respective optical axes define a V with a vertex angle substantially equal to 109°.--

--7. (amended) An analysing method as claimed in claim 1, wherein the first station (5) is equipped with two cameras (8, 9), and the second and third stations (6, 7) with one camera (12, 14).--

--8. (amended) An analysing method as claimed in claim 1, wherein three photographs of each product are taken at the first and third stations (5, 7), and a single photograph of the said products at the second station (6).--

--11. (amended) An analysing device as claimed in claim 9, wherein the distance between the first and second stations (5, 6) is substantially in the range between 1.1 and 1.2 times the distance between the second and third stations (6, 7).--

--13. (amended) An analysing device as claimed in claim 9, wherein the cameras (8, 9) of the station (5) comprising two cameras are advantageously orientated in such a way that their respective optical axes define a V with a vertex angle substantially equal to 109°.--

--14. (amended) An analyzing device as claimed in claim 9, wherein the means for driving the rollers (3, 4) in rotation comprise an endless belt (20) extending, underneath the conveyer line, along the analysing means, and arranged in such a way as to be tangential to the lower generatrix of the said rollers, and means for driving the said endless belt

which are suitable for causing the latter to run at a regulable running speed which is different from that of the conveyer line.--

R E M A R K S

The above changes in the claims merely place this national stage application in the same condition as it was during Chapter II of the international stage, with the multiple dependencies being removed.

Attached hereto is a marked-up version of the changes made to the claims by the current amendment. The attached page is captioned "VERSION WITH MARKINGS TO SHOW CHANGES MADE."

Respectfully submitted,

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December 28, 2001

VERSION WITH MARKINGS TO SHOW CHANGES MADE

Claims 4-8, 11, 13 and 14 have been amended as follows:

--4. (amended) An analysing method as claimed in ~~one of~~ ~~claims 2 or 3,~~claim 1, wherein a speed of rotation of the rollers (3, 4) is determined which is adapted so that a product of average diameter undergoes a rotation on itself with an angle of rotation substantially equal to 125.5° between the first and second stations (5, 6), and with an angle of rotation substantially equal to 109° between the second and the third stations (6, 7).--

--5. (amended) An analysing method as claimed in ~~one of~~ ~~claims 2 to 4,~~claim 2, wherein the distance between the first and second stations (5, 6) is substantially equal to 1.15 times the distance between the second and third stations (6, 7).--

--6. (amended) An analysing method as claimed in ~~one of~~ ~~claims 2 to 5,~~claim 2, wherein the cameras (8, 9) of the station (5) comprising two cameras are arranged in such a way that their respective optical axes define a V with a vertex angle substantially equal to 109° .--

--7. (amended) An analysing method as claimed in ~~one of~~ ~~the preceding claims,~~claim 1, wherein the first station (5) is equipped with two cameras (8, 9), and the second and third stations (6, 7) with one camera (12, 14).--

--8. (amended) An analysing method as claimed in ~~one of~~ ~~the preceding claims,~~claim 1, wherein three photographs of each product are taken at the first and third stations (5, 7), and a single photograph of the said products at the second station (6).--

--11. (amended) An analysing device as claimed in ~~one~~

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ANALYSING METHOD AND DEVICE WITH A VIEW TO THE AUTOMATIC
SORTING OF PRODUCTS SUCH AS PIECES OF FRUIT

The invention relates to an analysing method and device with
5 a view to the automatic sorting of products such as pieces
of fruit.

At the present time, numerous techniques exist which are
intended to permit the analysis of products such as pieces
10 of fruit, with a view to permitting the automatic sorting of
the said products in such a way as to obtain batches which
are homogeneous in terms of both quality and colour.

A first technique consists in arranging one or more cameras
15 above and/or on the side of a conveyer in such a way as to
analyse a surface portion of the pieces of fruit transported
on the said conveyer. However, this solution leads to a not
insignificant error rate, because only one portion of the
surface of the products is analysed. Consequently, defects
20 which these products exhibit on faces which are not visible
are not taken into account during sorting.

In order to overcome this drawback, one solution consists in
arranging four cameras which are distributed around a
25 conveyer, at its junction with another conveyer which is
raised in relation to the said conveyer, in such a way as to
analyse the pieces of fruit when they drop. This solution
does, in fact, make it possible to analyse the major part of
the surface of the products. In the first place, however,
30 this solution does not permit the analysis of the whole of
the upper and lower faces of the products. Moreover, the
fact that the products are subjected to dropping constitutes
a not insignificant risk of bruising them.

35 Another technique which is very commonly employed and which
is described, in particular, in US Patent 4,726,898,
consists in arranging a camera above the conveyer and in

causing the product to revolve on itself at high speed
plumb with the said camera. According to this
technique, the position and optical field of the camera are
adapted so that the latter displays four or five pieces of
5 fruit, so that a number of successive faces of each piece of
fruit which is driven in rotation are viewed successively by
the said camera. One of the advantages deriving from this
arrangement resides in the fact that a single camera permits
the analysis of pieces of fruit which are moving along on
10 two parallel conveyer lines. On the other hand, this
arrangement makes it necessary for the camera to be
relatively remote from the conveyer lines, and leads to a
loss of resolution which manifests itself in practice in an
inability to detect very small specks, such as "diffuse
15 russetting". Moreover, it turns out that, according to this
technique, those speeds of rotation of the pieces of fruit
which can be physically obtained lead to the displaying of
only about 80% of the total surface of the said pieces of
fruit. Finally, the defects in those zones of the pieces of
20 fruit which are viewed with a high degree of incidence turn
out to be poorly analysed. The consequence of this
combination of facts, is that, in practice, 25% to 30% of
the surface of the pieces of fruit is either simply not
analysed or else is poorly analysed.

25
In order to overcome this combination of drawbacks, other
solutions have been proposed which consist, for example, in
suspending the products or transporting them on a
transparent conveyer. However, these solutions have proved
30 unworkable in practice.

Another technique which is described in EP Patent 0,258,810,
consists in arranging a camera above the conveyer, a
plurality of mirrors which are distributed above and on the
35 sides of the said conveyer in such a way as to allow the
camera to display the upper face and side faces of the
products, and a plurality of lighting lamps distributed

above the said conveyer. Apart from the lower face of the products, which is resting on the conveyer, this solution therefore permits the analysis of the major part of the surface of the said products without the risk of bruising the latter. However, the implementation of such a technique proves to be relatively complex. In fact, the said implementation makes it necessary, in particular, to arrange the lighting lamps in such a way as not to dazzle the camera, an arrangement which proves awkward to obtain if it is desired to obtain uniform lighting. Likewise, the relative positions of the camera and the various mirrors have to be absolutely precise, and this proves to be not very easy because of the congestion problems linked with the presence of the conveyer. Furthermore, the principle adopted, which consists in using a CCD camera divided up into analysing segments, leads to a not insignificant reduction in the resolution of the sensor.

Another technique, which is described in Patent Application WO 94/10555 and US Patent 5,156,278, consists firstly in providing four successive analysing stations arranged at a distance from one another along the conveyer and each comprising a lens which is arranged plumb with the said conveyer and connected to a lens/filters/photodiodes unit by an optical cable. Moreover, according to this technique, the pieces of fruit are carried by a conveyer equipped with rollers which are mounted so as to rotate freely about a transverse axis, and the said rollers are caused to revolve about their axes of rotation between the stations, so that each piece of fruit undergoes a rotation of about 90° between two stations, whereas the said piece of fruit is rotationally immobile when plumb with each of the stations. Such a technique therefore makes it possible to display the whole of the surface of the pieces of fruit owing to the fact that complementary faces of the latter are analysed at each station. However, it has one drawback which results from the differences in size of the pieces of fruit

analysed. In actual fact, the rotation which a piece of fruit with a given diameter undergoes differs from that undergone by a fruit with a different diameter so that, since the angle of rotation is necessarily calculated for a
5 piece of fruit with a given average diameter, pieces of fruit which are larger in size are not viewed in their entirety, whereas overlapping zones of pieces of fruit which are smaller in size are displayed, leading to erroneous analysis of the surface of the said pieces of fruit.

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The present invention sets out to overcome all the drawbacks of the techniques described above, and has the essential object of providing a product-analysing device which is very simple to implement and operate and which permits the
15 analysis of the whole of the surface of the said products in spite of differences in the dimensions of the latter.

To that end, the invention relates to an analysing method with a view to sorting products such as pieces of fruit
20 which are transported along an axis (x) on a conveyer line having a plurality of rollers which are mounted so as to each rotate freely about a transverse axis of rotation orthogonal to the axis (x), and which are spaced apart in such a way that two adjoining rollers define, between them,
25 a seating for a product, the said analysing method consisting in using analysing means which are split up into a number of successive stations arranged at a distance from one another along the axis (x), and in causing the rollers to revolve about their axes of rotation between the stations
30 in such a way as to display, at each of the said stations, different faces of each product.

In the said analysing method according to the invention:

35 - three analysing stations are arranged along the conveyer line, and each of the said analysing stations is equipped with at least one camera which is orientated and adapted to

make, with an adjustable frequency, photographs of the products transported by the conveyer line,

. one of the said stations having two cameras which are
5 arranged on either side of the conveyer line in the same vertical plane orthogonal to the axis (x), and are orientated in such a way that their respective optical axes form a V which is centred on the said axis (x) and has a vertex angle substantially in the range between 90° and
10 130°,

. the other two stations each comprising a camera which is arranged plumb with the conveyer line and is orientated in such a way that its optical axis is vertical and secant
15 with the axis (x),

- in a preliminary phase, there are determined the average diameter of the products to be analysed and, as a function of the said average diameter, a speed of rotation of the
20 rollers which is adapted so that a product of average diameter which is located in the plane of a camera at the first station and is caused to revolve on itself along the whole of the analysing means under the effect of the rotation of the said rollers, undergoes a rotation such that
25 four complementary zones on its surface are viewed by the respective cameras of the first, second and third stations,

- and during the conveying of the products, the rollers are caused to revolve continuously at the predetermined speed of
30 rotation, and for each product:

. m_i photographs of this product are made at the first station, where $i \geq 3$, n_j photographs at the second station, where $j \geq 1$, and p_k photographs at the third station, where
35 $k \geq 3$,

. the theoretical diameter of the product is calculated

from the photographs made,

. and the photographs m_i , n_j and p_k to be taken into account with a view to analysing the said product are
5 determined by comparison of the theoretical diameter of this product with the predetermined average diameter, in such a way as to obtain a complete analysis, without overlapping or with a given overlap, of the total surface of the said product.

10

According to the method of the invention, on the one hand the cameras are arranged and orientated, and on the other, each product is caused to revolve continuously during its transport along the analysing device, in such a way that the
15 said product is displayed in accordance with four different angles adapted to permit the analysis of four complementary faces of a product with a given average diameter. Moreover, in order to take into account the differences in diameter of the products analysed in relation to the predetermined

20 average diameter:

. the theoretical diameter of each product is, first of all, determined in conventional manner,

25 . the nature of the photograph to be taken into account with a view to analysis is deduced, from among the photographs made at the various stations, from the comparison between the theoretical diameter calculated and the predefined average diameter, in such a way as to obtain a complete
30 analysis of the total surface of the product. This selection of the photographs to be analysed is carried out very easily. By way of example, if the photographs m_i , n_j and p_k correspond to a product of average diameter, and if i , j , k , photographs are taken at each station, where $i - x$
35 $\leq i \leq i + x$, $j - y \leq j \leq j + y$, and $k - z \leq k \leq k + z$, the photographs will be:

- . in the case of a product with a theoretical diameter substantially equal to the average diameter: m_i , n_j , p_k ,
- . in the case of a product with a diameter smaller than the average diameter, $m(i + x)$, $n(j - y)$ and $p(k - z)$ photographs, where x , y , z are of an order which is a function of the difference in diameter,
- . in the case of a product with a diameter greater than the average diameter, $m(i - x)$, $n(j + y)$ and $p(k + z)$ photographs, where x , y , z are of an order which is a function of the difference in diameter.

- A method of this kind which therefore combines the use of a number of cameras distributed and orientated in a specific manner, the setting of the products in rotation at a given speed of rotation, and the selection of the photographs taken by the cameras as a function of the theoretical diameter of the products, permits the analysis of the whole of the surface of each product without overlapping or with a known overlap, and to do so in spite of the differences in size of the said products.

- According to one advantageous mode of implementation, a speed of rotation of the rollers is determined which is adapted so that a product of average diameter undergoes a rotation on itself with an angle of rotation substantially in the range between 110° and 130° between the first and second stations, and with an angle of rotation substantially in the range between 105° and 115° between the second and third stations.

- These angles of rotation, which are associated with the arrangement of the two cameras situated at one of the stations, lead to the obtention of shots of each product which are equivalent to those which would be obtained from four cameras arranged at the four vertices of a tetrahedron

and orientated towards the barycentre of the said tetrahedron, by placing the product at the said barycentre.

These angles of rotation may advantageously be obtained:

5

. by arranging the stations of analysing means in such a way that the distance between the first and second stations is substantially in the range between 1.1 and 1.2 times the distance between the second and third stations,

10

. and by causing the rollers to revolve in rotation at a constant speed of rotation along the whole of the said analysing device.

- 15 According to one advantageous mode of implementation, a speed of rotation of the rollers is determined which is adapted so that a product of average diameter undergoes a rotation on itself with an angle of rotation substantially equal to 125.5° between the first and second stations, and
20 with an angle of rotation substantially equal to 109° between the second and third stations.

Moreover, the cameras of the station comprising two cameras are advantageously arranged in such a way that their
25 respective optical axes define a V with a vertex angle substantially equal to 109° .

- These angles of rotation and orientation of the two cameras lead to the obtention of an optimum shooting system
30 equivalent to a system whose four cameras would be arranged at the four vertices of a regular tetrahedron.

- In order to obtain these angles of rotation, and in an advantageous manner, the distance between the first and
35 second stations is substantially equal to 1.15 times the distance between the second and third stations.

Furthermore, the first station is advantageously equipped with two cameras, and the second and third stations with one camera. The fact that the two cameras are arranged at the first station permits better definition of the theoretical
5 diameter of the products.

Furthermore, and in an advantageous manner, three photographs of each product are taken at the first and third stations, and a single photograph of the said products at
10 the second station.

The invention extends to an analysing device with a view to the automatic sorting of products such as pieces of fruit, the said device comprising:

15 . a conveyer line for transporting the products along a longitudinal axis (x), the said line having a plurality of rollers which are mounted so as to each rotate freely about a transverse axis of rotation orthogonal to the axis (x) and
20 are spaced apart in such a way that two adjoining rollers define, between them, a seating for a product,

. means for analysing the surface of the products, which means are arranged above the conveyer line and have a number
25 of successive stations arranged at a distance from one another along the axis (x),

. means for driving the rollers in rotation about their axes of rotation, which means are suitable for bringing about
30 rotation of the said rollers between the analysing stations in such a way that different faces of the products are analysed at each station,

. and a processing unit adapted to receive information
35 emanating from the analysing means, and to calculate workable sorting data from predefined, programmed criteria.

In the said analysing device according to the invention:

- . the analysing means comprise three analysing stations, each of the said analysing stations having at least one
5 camera which is orientated and adapted to make, with an adjustable frequency, photographs of the products transported by the conveyer line,
- . one of the said stations having two cameras which are
10 arranged on either side of the conveyer line in the same vertical plane orthogonal to the axis (x), and are orientated in such a way that their respective optical axes form a V which is centred on the said axis (x) and has a vertex angle substantially in the range between 90° and
15 130°,
- . the other two stations each comprising a camera which is arranged plumb with the conveyer line and is orientated in such a way that its optical axis is vertical and secant with
20 the axis (x),
- . the means for driving the rollers in rotation are arranged in such a way as to bring about continuous rotation of the said rollers along the analysing means, at a speed of
25 rotation which is adapted so that a product of predetermined average diameter which is located in the plane of a camera at the first station and is caused to revolve on itself along the whole of the analysing means under the effect of the rotation of the said rollers, undergoes a rotation such
30 that four complementary zones of its surface are viewed by the respective cameras of the first, second and third stations,
- . the processing unit is adapted to:
35
 - . process, for each product, m_i photographs of the said products taken at the first station, where $i \geq 3$, n_j

photographs taken at the second station, where $j \geq 1$, and p_k photographs, at the third station, where $k \geq 3$,

. and to determine, by a comparison of the theoretical
5 diameter of the said product with the predetermined average diameter, the m_i , n_j and p_k photographs to be taken into account with a view to analysing the said product, in such a way as to obtain a complete analysis, without overlapping or with a given overlap, of the total surface of the said
10 product.

According to an advantageous mode of embodiment, the first station has two cameras, while the second and third stations have a single camera.

15 Moreover, the distance between the first and second stations is advantageously substantially in the range between 1.1 and 1.2 times the distance between the second and third stations. This distance between the first and second
20 stations is preferably substantially equal to 1.15 times the distance between the second and third stations.

Moreover, the cameras of the station comprising two cameras are advantageously orientated in such a way that their
25 respective optical axes define a V with a vertex angle substantially equal to 109° .

Furthermore, according to one advantageous mode of embodiment, the means for driving the rollers in rotation
30 comprise an endless belt extending, underneath the conveyer line, along the analysing means, and arranged in such a way as to be tangential to the lower generatrix of the said rollers, and means for driving the said endless belt which are suitable for causing the latter to run at a regulable
35 running speed which is different from that of the conveyer line.

Moreover, the means for driving the endless belt are advantageously adapted to drive it in the same direction of displacement as that of the conveyer line at an adjustable running speed which is lower than that of the said conveyer
5 line.

Other characteristics, aims and advantages of the invention will emerge from the detailed description which follows, with reference to the appended drawings which represent, by
10 way of a non-limitative example, a preferred mode of embodiment of the invention. In the said drawings:

- figure 1 is a view, in diagrammatic perspective, of an analysing device according to the invention, installed on a
15 conveyer device having two product-conveying lines,
- figure 2 is a diagrammatic longitudinal section through a vertical plane B of the said analysing device,
- 20 - and figure 3 is a front view of the said analysing device, in the direction of the arrow A.

In the figures, the analysing device according to the invention is represented installed on a fruit-conveying
25 device having two parallel conveying lines 1, 2. Each of these conveying lines 1, 2 comprises a plurality of rollers such as 3, 4 which are mounted so as to each rotate freely about a transverse axis of rotation, and are spaced apart in such a way that two successive rollers define, between them,
30 a seating for a piece of fruit. Conveyer lines of this kind are, for example, of the same type as those described in Patent Application FR-2,772,358, to which reference may be made for more details.

35 This analysing device comprises three analysing stations, 5, 6, 7 which are arranged successively at a distance from one another along the conveyer lines 1, 2, and have, for each of

the said conveyer lines:

5 . in the case of the first station 5, two cameras 8, 9-10,
11 arranged on either side of the conveyer line 1-2, in the
same vertical plane orthogonal to the direction of
displacement of the said conveyer line, the said cameras
being orientated in such a way that their optical axes form
a V which is centred on a piece of fruit of average diameter
and has a vertex angle substantially in the range between
10 90° and 130°,

15 . in the case of the second station 6, a camera 12-13 which
is arranged plumb with the conveyer line 1-2, and is
orientated in such a way that its optical axis is vertical
and secant in relation to the longitudinal axis of the said
conveyer line,

20 . in the case of the third station 7, a camera 14-15 which
is arranged plumb with the conveyer line 1-2, and is
orientated in such a way that its optical axis is vertical
and secant in relation to the longitudinal axis of the said
conveyer line.

Moreover, the analysing stations 5, 6, 7 are spaced apart
25 from one another in such a way that the distance 11 between
the optical axes of the respective cameras 8-11 and 12-13 of
the first station 5 and second station 6 is equal to 1.15
times the distance 12 between the optical axes of the
respective cameras 12-13, 14-15 of the second station 6 and
30 third station 7. In practice, by way of an example, 11 is
substantially equal to 26 cm, and 12 is therefore
substantially equal to 22 cm.

Moreover, the cameras 12-15 of the second station 6 and
35 third station 7 are arranged in such a way that their lenses
are situated at a height h1 which is substantially equal to
80 cm above the conveyer lines, whereas the lens of the

cameras 8-11 of the first station 5 extends to a height $h_1 - h_2$, where h_2 is substantially equal to 9 cm, above the said conveyer lines.

- 5 Furthermore, each camera 8-15 has, in a single casing, two distinct cameras such as 16, 17 which are adapted to make photographs which are fully superimposable: a conventional (RVB) camera 16 and an infrared camera 17. Moreover, these cameras 16, 17 are "single-shot" cameras suitable for taking
10 in the region of 25 photographs per second.

The group of cameras 8-15 is integrated into a single case 18 of conventional type, which also incorporates lighting means such as 19, of a type which is known *per se*.

- 15 The analysing device according to the invention further comprises, plumb with the case 18 and for each conveyer line 1, 2, an endless belt 20, 21, which is arranged in such a way as to come into tangential contact with the lower
20 generatrix of the rollers 3, 4, and means for driving the said endless belts, which means are suitable for displacing them at an adjustable speed in the same direction of displacement as that of the said conveyer lines.

- 25 The functioning of the analysing device according to the invention is described below.

- First of all, and in a preliminary phase, the average diameter of the pieces of fruit conveyed is determined. The
30 speed of displacement of the endless belts 20, 21 is then adjusted, as a function of the running speed of the conveyer lines 1, 2, in such a way that the rotation of the rollers 3, 4 leads an average piece of fruit to undergo a rotation on itself with an angle of 125.5° over the distance 11
35 separating the first and second stations 5, 6 and consequently, taking into account the constant running speed of the said endless belts and conveyer lines, a rotation on

itself of 109° over the distance 12 separating the second and third stations 6, 7.

In the course of analysis, three m_i photographs, where $i - 1 \leq i \leq i + 1$, of each piece of fruit are taken at the first station 5, a single photograph n at the second station, and three p_k photographs, where $k - 1 \leq k \leq k + 1$ at the third station.

10 After conventional, analog/numerical type conversion, these photographs are stored and their processing consists in:

- calculating the theoretical diameter of each piece of fruit from the m_i and n photographs taken at the first and
15 second stations 5, 6,

- determining, from the calculation of the theoretical diameter, the photographs to be taken into account with a view to calculating the workable sorting data, the said
20 determination consisting in selecting:

- . in the case of a piece of fruit with a diameter equal or close to the average diameter, the m_i , n and p_k photographs,
- 25 . in the case of a piece of fruit of small size, that is to say with a diameter smaller than the average diameter, the $m_{(i + 1)}$, n and $p_{(k - 1)}$ photographs,
- . and, in the case of a piece of fruit of large size, that
30 is to say with a diameter greater than the average diameter, the $m_{(i - 1)}$, n and $p_{(k + 1)}$ photographs.

It should be noted that although the figures represent a conveyer equipped with two conveyer lines, the analysing
35 device can be installed on a conveyer equipped with n parallel lines, where $n \geq 1$, the number of cameras 8-15 then

being equal to $4n$, with $2n$ cameras at the first station 5,
and n cameras at each of the second and third stations 6, 7.

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CLAIMS

1. An analysing method with a view to sorting products such as pieces of fruit which are transported along an axis (x) on a conveyer line having a plurality of rollers (3, 4) which are mounted so as to each rotate freely about a transverse axis of rotation orthogonal to the axis (x), and which are spaced apart in such a way that two adjoining rollers (3, 4) define, between them, a seating for a product, the said analysing method consisting in using analysing means which are split up into a number of successive stations (5, 6, 7) arranged at a distance from one another along the axis (x), and in causing the rollers (3, 4) to revolve about their axes of rotation between the stations (5, 6, 7) in such a way as to display, at each of the said stations, different faces of each product, wherein:
- three analysing stations (5-7) are arranged along the conveyer line, and each of the said analysing stations is equipped with at least one camera (8, 9, 12, 14) which is orientated and adapted to make, with an adjustable frequency, photographs of the products transported by the conveyer line,
 - . one of the said stations (5) having two cameras (8, 9) which are arranged on either side of the conveyer line in the same vertical plane orthogonal to the axis (x), and are orientated in such a way that their respective optical axes form a V which is centred on the said axis (x) and has a vertex angle substantially in the range between 90° and 130°,
 - . the other two stations (6, 7) each comprising a camera (12, 14) which is arranged plumb with the conveyer line and is orientated in such a way that its optical axis is vertical and secant with the axis (x),

- in a preliminary phase, there are determined the average diameter of the products to be analysed and, as a function of the said average diameter, a speed of rotation of the rollers (3, 4) which is adapted so that a product of average diameter which is located in the plane of a camera (8, 9) at the first station (5) and is caused to revolve on itself along the whole of the analysing means under the effect of the rotation of the said rollers, undergoes a rotation such that four complementary zones on its surface are viewed by the respective cameras (8, 9, 12, 14) of the first, second and third stations (5-7),

- and during the conveying of the products, the rollers (3, 4) are caused to revolve continuously at the predetermined speed of rotation, and for each product:

. m_i photographs of this product are made at the first station (5), where $i \geq 3$, n_j photographs at the second station (6), where $j \geq 1$, and p_k photographs at the third station (7), where $k \geq 3$,

. the theoretical diameter of the product is calculated from the photographs made,

. and the photographs m_i , n_j and p_k to be taken into account with a view to analysing the said product are determined by comparison of the theoretical diameter of the said product with the predetermined average diameter, in such a way as to obtain a complete analysis, without overlapping or with a given overlap, of the total surface of the said product.

2. An analysing method as claimed in claim 1, wherein a speed of rotation of the rollers (3, 4) is determined which is adapted so that a product of average diameter undergoes a rotation on itself with an angle of rotation substantially in the range between 110° and 130° between the first and

second stations (5, 6), and with an angle of rotation substantially in the range between 105° and 115° between the second and third stations (6, 7).

5 3. An analysing method as claimed in claim 2, wherein the stations (5-7) of analysing means are arranged in such a way that the distance between the first and second stations (5, 6) is substantially in the range between 1.1 and 1.2 times the distance between the second and third stations (6, 7),
10 and the rollers (3, 4) are caused to revolve in rotation at a constant speed of rotation along the whole of the said analysing device.

4. An analysing method as claimed in one of claims 2 or 3,
15 wherein a speed of rotation of the rollers (3, 4) is determined which is adapted so that a product of average diameter undergoes a rotation on itself with an angle of rotation substantially equal to 125.5° between the first and second stations (5, 6), and with an angle of rotation
20 substantially equal to 109° between the second and third stations (6, 7).

5. An analysing method as claimed in one of claims 2 to 4, wherein the distance between the first and second stations
25 (5, 6) is substantially equal to 1.15 times the distance between the second and third stations (6, 7).

6. An analysing method as claimed in one of claims 2 to 5, wherein the cameras (8, 9) of the station (5) comprising two
30 cameras are arranged in such a way that their respective optical axes define a V with a vertex angle substantially equal to 109° .

7. An analysing method as claimed in one of the preceding
35 claims, wherein the first station (5) is equipped with two cameras (8, 9), and the second and third stations (6, 7) with one camera (12, 14).

8. An analysing method as claimed in one of the preceding claims, wherein three photographs of each product are taken at the first and third stations (5, 7), and a single photograph of the said products at the second station (6).
- 5 9. An analysing device with a view to the automatic sorting of products such as pieces of fruit, the said device comprising:
- 10 . a conveyer line for transporting the products along a longitudinal axis (x), the said line having a plurality of rollers (3, 4) which are mounted so as to each rotate freely about a transverse axis of rotation orthogonal to the axis (x) and are spaced apart in such a way that two adjoining
- 15 rollers (3, 4) define, between them, a seating for a product,
- . means for analysing the surface of the products, which means are arranged above the conveyer line and have a number
- 20 of successive stations (5-7) arranged at a distance from one another along the axis (x),
- . means (20) for driving the rollers (3, 4) in rotation about their axes of rotation, which means are suitable for
- 25 bringing about rotation of the said rollers between the analysing stations (5-7) in such a way that different faces of the products are analysed at each station,
- . and a processing unit adapted to receive information
- 30 emanating from the analysing means, and to calculate workable sorting data from predefined, programmed criteria,
- wherein:
- 35 . the analysing means comprise three analysing stations, each of the said analysing stations (5-7) having at least one camera (8, 9, 12, 14) which is orientated and adapted to

make, with an adjustable frequency, photographs of the products transported by the conveyer line,

- 5 . one of the said stations (5) having two cameras (8, 9) which are arranged on either side of the conveyer line in the same vertical plane orthogonal to the axis (x), and are orientated in such a way that their respective optical axes form a V which is centred on the said axis (x) and has a vertex angle substantially in the range between 90° and 10 130°,
- 15 . the other two stations (6, 7) each comprising a camera (12, 14) which is arranged plumb with the conveyer line and is orientated in such a way that its optical axis is vertical and secant with the axis (x),
- 20 . the means (20) for driving the rollers (3, 4) in rotation are arranged in such a way as to bring about continuous rotation of the said rollers along the analysing means, at a speed of rotation which is adapted so that a product of predetermined average diameter which is located in the plane of a camera (8, 9) at the first station (5) and is caused to revolve on itself along the whole of the analysing means under the effect of the rotation of the said rollers,
- 25 undergoes a rotation such that four complementary zones of its surface are viewed by the respective cameras (8, 9, 12, 14) of the first, second and third stations (5-7),
- 30 . the processing unit is adapted to:
 - 35 . process, for each product, m_i photographs of the said products taken at the first station (5), where $i \geq 3$, n_j photographs taken at the second station (6), where $j \geq 1$, and p_k photographs taken at the third station (7), where $k \geq 3$,
 - . and to determine, by a comparison of the theoretical

diameter of this product with the predetermined average diameter, the mi, nj and pk photographs to be taken into account with a view to analysing the said product, in such a way as to obtain a complete analysis, without overlapping or
5 with a given overlap, of the total surface of the said product.

10. An analysing device as claimed in claim 9, wherein the first station (5) has two cameras (8, 9), the second and
10 third stations (6, 7) having a single camera (12, 14).

11. An analysing device as claimed in one of claims 9 or 10, wherein the distance between the first and second stations (5, 6) is substantially in the range between 1.1 and 1.2
15 times the distance between the second and third stations (6, 7).

12. An analysing devices as claimed in claim 11, wherein the distance between the first and second stations (5, 6) is
20 substantially equal to 1.15 times the distance between the second and third stations (6, 7).

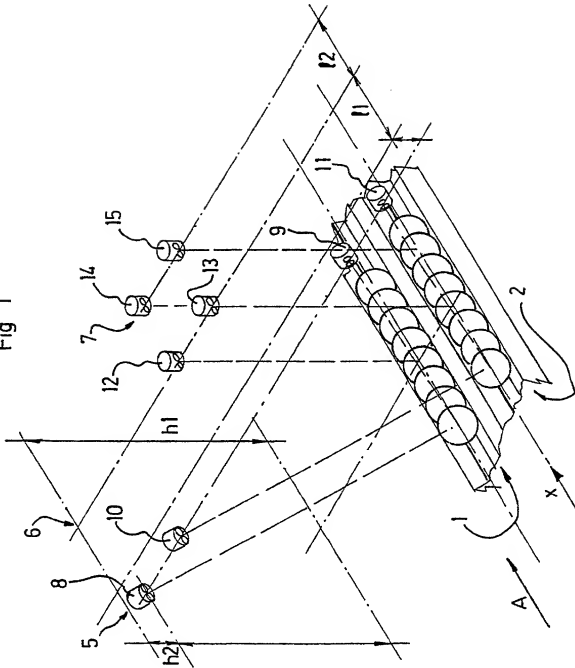
13. An analysing device as claimed in one of claims 9 to 12, wherein the cameras (8, 9) of the station (5) comprising two
25 cameras are advantageously orientated in such a way that their respective optical axes define a V with a vertex angle substantially equal to 109°.

14. An analysing device as claimed in one of claims 9 to 13,
30 wherein the means for driving the rollers (3, 4) in rotation comprise an endless belt (20) extending, underneath the conveyer line, along the analysing means, and arranged in such a way as to be tangential to the lower generatrix of the said rollers, and means for driving the said endless
35 belt which are suitable for causing the latter to run at a regulable running speed which is different from that of the conveyer line.

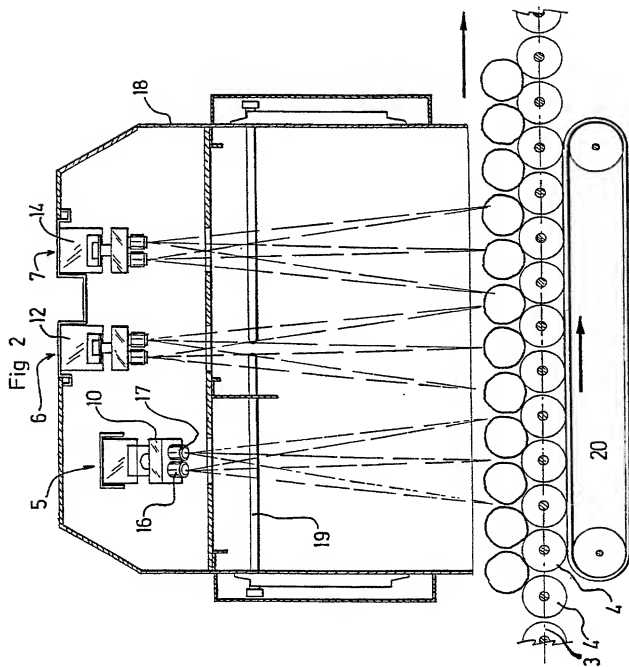
15. An analysing device as claimed in claim 14, wherein the means for driving the endless belt (20) are adapted to drive it in the same direction of displacement as that of the conveyer line at an adjustable running speed which is lower
5 than that of the said conveyer line.

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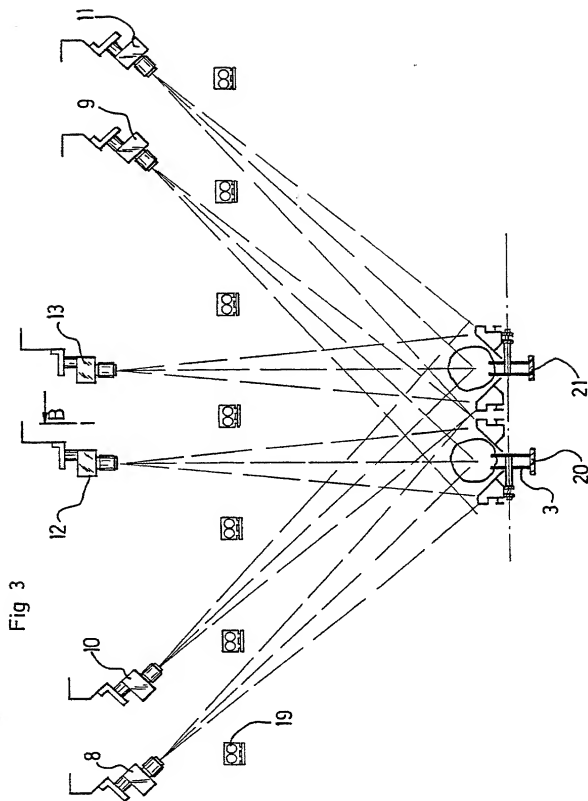
Fig 1



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Declaration and Power of Attorney for Patent Application

Déclaration et Pouvoirs pour Demande de Brevet

French Language Declaration

En tant que l'inventeur nommé ci-après, je déclare par le présent acte que:

Mon domicile, mon adresse postale et ma nationalité sont ceux figurant ci-dessous à côté de mon nom.

Je crois être le premier inventeur original et unique (si un seul nom est mentionné ci-dessous), ou l'un des premiers co-inventeurs originaux (si plusieurs noms sont mentionnés ci-dessous) de l'objet revendiqué, pour lequel une demande de brevet a été déposée concernant l'invention intitulée

PROCEDE ET DISPOSITIF D'ANALYSE EN VUE DU

TRI AUTOMATIQUE DE PRODUITS TELS QUE DES
FRUITS

et dont la description est fournie ci-joint à moins que la case suivante n'ait été cochée:

☒ a été déposée le 06 juin 2000
sous le numéro de demande des Etats-Unis ou le
numéro de demande internationale PCT
PCT/FR 00/01545 et modifiée le
/ (le cas échéant).

Je déclare par le présent acte avoir passé en revue et compris le contenu de la description ci-dessus, revendications comprises, telles que modifiées par toute modification dont il aura été fait référence ci-dessus.

Je reconnais devoir divulguer toute information pertinente à la brevetabilité, comme défini dans le Titre 37, § 1.56 du Code fédéral des réglementations.

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

ANALYSING METHOD AND DEVICE WITH A VIEW

TO THE AUTOMATIC SORTING OF PRODUCTS SUCH
AS PIECES OF FRUIT

the specification of which is attached hereto unless the following box is checked:

☐ was filed on _____
as United States Application Number or PCT
International Application Number
_____ and was amended on
_____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56.

French Language Declaration

Je revendique par le présent acte avoir la priorité étrangère, en vertu du Titre 35, § 119(a)-(d) ou § 365(b) du Code des Etats-Unis, sur toute demande étrangère de brevet ou certificat d'inventeur ou, en vertu du Titre 35, § 365(a) du même Code, sur toute demande internationale PCT désignant au moins un pays autre que les Etats-Unis et figurant ci-dessous et, en cochant la case, j'ai aussi indiqué ci-dessous toute demande étrangère de brevet, tout certificat d'inventeur ou toute demande internationale PCT ayant une date de dépôt précédant celle de la demande à propos de laquelle une priorité est revendiquée.

Prior foreign applications

Demande(s) de brevet antérieure(s) dans un autre pays:

99.08227	France	28 June 1999
(Number) (Numéro)	(Country) (Pays)	(Day/Month/Year Filed) (Jour/Mois/Année de dépôt)
(Number) (Numéro)	(Country) (Pays)	(Day/Month/Year Filed) (Jour/Mois/Année de dépôt)
(Number) (Numéro)	(Country) (Pays)	(Day/Month/Year Filed) (Jour/Mois/Année de dépôt)

Je revendique par le présent acte tout bénéfice, en vertu du Titre 35, § 119(e) du Code des Etats-Unis, de toute demande de brevet provisoire effectuée aux Etats-Unis et figurant ci-dessous.

(Application No.) (N° de demande)	(Filing Date) (Date de dépôt)
(Application No.) (N° de demande)	(Filing Date) (Date de dépôt)

Je revendique par le présent acte tout bénéfice, en vertu du Titre 35, § 120 du Code des Etats-Unis, de toute demande de brevet effectuée aux Etats-Unis, ou en vertu du Titre 35, § 365(c) du même Code, de toute demande internationale PCT désignant les Etats-Unis et figurant ci-dessous et, dans la mesure où l'objet de chacune des revendications de cette demande de brevet n'est pas divulgué dans la demande antérieure américaine ou internationale PCT, en vertu des dispositions du premier paragraphe du Titre 35, § 112 du Code des Etats-Unis, je reconnais devoir divulguer toute information pertinente à la brevetabilité, comme défini dans le Titre 37, § 1.56 du Code fédéral des réglementations, dont j'ai pu disposer entre la date de dépôt de la demande antérieure et la date de dépôt de la demande nationale ou internationale PCT de la présente demande:

(Application No.) (N° de demande)	(Filing Date) (Date de dépôt)
(Application No.) (N° de demande)	(Filing Date) (Date de dépôt)

Je déclare par le présent acte que toute déclaration ci-incluse est, à ma connaissance, véridique et que toute déclaration formulée à partir de renseignements ou de suppositions est tenue pour véridique; et de plus, que toutes ces déclarations ont été formulées en sachant que toute fausse déclaration volontaire ou son équivalent est passible d'une amende ou d'une incarcération, ou des deux, en vertu de la Section 1001 du Titre 18 du Code des Etats-Unis, et que de telles déclarations volontairement fausses risquent de compromettre la validité de la demande de brevet ou du brevet délivré à partir de celle-ci.

I hereby claim foreign priority under Title 35, United States Code, § 119(a)-(d) or § 365 (b) of any foreign application(s) for patent or inventor's certificate, or § 365(a) of any PCT International application which designated at least one country other than the United States, listed below, and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

Priority claimed

Droit de priorité revendiqué

<input checked="" type="checkbox"/>	<input type="checkbox"/>
Yes Oui	No Non
<input type="checkbox"/>	<input type="checkbox"/>
Yes Oui	No Non
<input type="checkbox"/>	<input type="checkbox"/>
Yes Oui	No Non

I hereby claim the benefit under Title 35, United States Code, § 119(e) of any United States provisional application(s) listed below.

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s), or § 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application.

(Status) (patented, pending, abandoned) (Statut) (breveté, en cours d'examen, abandonné)
(Status) (patented, pending, abandoned) (Statut) (breveté, en cours d'examen, abandonné)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

French Language Declaration

POUVOIRS: En tant que l'inventeur cité, je désigne par la présente l'(les) avocat(s) et/ou agent(s) suivant(s) pour qu'ils poursuive(nt) la procédure de cette demande de brevet et traite(nt) toute affaire s'y rapportant avec l'Office des brevets et des marques: (mentionner le nom et le numéro d'enregistrement).

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: (list name and registration number)

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Nom complet du seul ou premier inventeur Philippe BLANC		Full name of sole or first inventor	
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Signature de l'inventeur		Second Inventor's signature	
Date		Date	
Domicile		Residence	
Nationalité		Citizenship	
Adresse Postale		Post Office Address	

(Fournir les mêmes renseignements et la signature de tout co-inventeur supplémentaire.)

(Supply similar information and signature for third and subsequent joint inventors.)